

FORM PTO-1200 (REV. 11-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 668-62
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371			U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/913565
INTERNATIONAL APPLICATION NO. PCT/GB00/00568	INTERNATIONAL FILING DATE 17/FEBRUARY2000	PRIORITY DATE CLAIMED 18/FEBRUARY/1999	
TITLE OF INVENTION VEHICLE DETECTOR AND CLASSIFIER			
APPLICANT(S) FOR DO/EO/US Gordon Johnston POVEY, ET AL.			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below. 4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31). 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau). b. <input checked="" type="checkbox"/> has been communicated by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). a. <input checked="" type="checkbox"/> is attached hereto. b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). 7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input checked="" type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (signed) 10. <input type="checkbox"/> An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).			
Items 11 to 20 below concern document(s) or information included:			
11. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 12. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 13. <input checked="" type="checkbox"/> A FIRST preliminary amendment. 14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 15. <input type="checkbox"/> A substitute specification. 16. <input type="checkbox"/> A change of power of attorney and/or address letter. 17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825. 18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4). 19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). 20. <input checked="" type="checkbox"/> Other items or information:			
Cert/Express Mail Copies of: PCT Request/PCT Demand PCT IPR/409 Cover Sheet of Published Appln. WO 00/49500 PCT International Search Report (and references) Preliminary Amendment/Postcard			

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518 Rec'd PCT/PTO 14 AUG 2001

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: **Gordon Johnston POVEY, ET AL.**

International Application No. PCT/GB00/00568

International Filing Date: 17/FEBRUARY/2000

U.S. Serial No.: NOT YET KNOWN

U.S. Filing Date: HERewith

For: VEHICLE DETECTOR AND CLASSIFIER

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, DC 20231
ATTN: BOX PCT

Sir:

Please amend the above-identified patent application, as follows:

IN THE CLAIMS

Amend claims 4, 7, 8, 9, and 10 as follows:

4.(amended). A detector according to claim 1, characterized in that a plurality of loops are arranged in a line in a single slot cut into the road surface.

7.(amended). A detector according to claim 1, wherein the loop, or all of the loops, are encapsulated in a semi-rigid enclosure.

8.(amended). A detector according to claim 1, wherein each loop, is substantially rectangular.

9.(amended). A detector according to claim 1, wherein each loop comprises a plurality of turns.

10. (amended). A detector according to claim 1, including an inductive loop arranged substantially in the plane of the road surface.

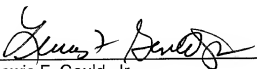
REMARKS

This Preliminary Amendment is made to place the subject application in better form for examination in the U.S. Patent and Trademark Office. Claims 4, 7, 8, 9 and 10 have been amended to eliminate the informalities. No new matter has been added.

The number of claims remains within that permitted under the filing fees. Please enter the Preliminary Amendment prior to examination and before calculating filing fees. A clean copy of the claims as amended is provided for the convenience of the examiner.

Respectfully submitted,

Date: August 14, 2001



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Docket No: 668-62 (D4742-00063)

MARKED UP VERSION OF CLAIMS SHOWING CHANGES

4.(amended). A detector according to [any preceding] claim 1, characterized in that a plurality of loops are arranged in a line in a single slot cut into the road surface.

7.(amended). A detector [according] according to [any preceding] claim 1, wherein the loop, or all of the loops, are encapsulated in a semi-rigid enclosure.

8.(amended). A detector according to [any preceding] claim 1, wherein [the or] each loop is substantially rectangular.

9.(amended). A detector according to [any preceding] claim 1, wherein [the or] each loop comprises a plurality of turns.

10.(amended). A detector according to [any preceding] claim 1, including an inductive loop arranged substantially in the plane of the road surface.

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VEHICLE DETECTOR AND CLASSIFIER

Background to the Invention

The present invention relates to a vehicle detector and classifier.

5 There is a growing world-wide market for systems for detecting and classifying road vehicles. Road tolling, road pricing, and traffic monitoring and control are becoming increasingly important. Such systems are also likely to be of use in the automated or intelligent highways of the future.

10 Accurate, low cost, low maintenance sensors are required which can not only detect but classify vehicles for automatic tolling and priority lane enforcement. The invention is also applicable to aircraft ground control and military vehicle classification.

15 One form of vehicle detector in common use comprises one or two large loops of electrically conductive material which are arranged on or in a road, substantially in the plane of the road surface. Vehicles are detected by the reduction in the inductance of the loop caused by the metallic vehicle body

20 passing thereover.

 Whilst detectors of this kind can be used to classify vehicles according to their length, they do not detect the axles or wheels of the vehicle and hence classification according to the number, type and position of axles or wheels

25 is not possible. Such classification is, however, the accepted and sensible way to classify vehicle types.

 Axle classification can be achieved by using a pneumatic tube or piezoelectric sensor in addition to the inductive loop. However, this adds to the cost, is impractical on

30 unsurfaced roads, has a limited life span and cannot detect individual wheel configurations.

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It is therefore highly desirable to provide an inductive loop vehicle detector which can detect vehicle wheels.

EP-A-0,649,553 describes a vehicle detector comprising at least one and up to eight inductive loops, having a width
5 (extending in the direction of travel) only substantially equal to the bearing surface on the ground of the vehicle wheel (i.e. about 0.3 m for heavy goods vehicles or 0.15 m for light vehicles). The or each loop is arranged substantially in the plane of the road surface. This arrangement is able
10 to detect vehicle wheels although the influences of the metallic masses of the body and of the tyres of the vehicle on such small loops are opposed.

The reason given in EP-A-0,649,553 for these opposite influences is that the loop or loops constitute a first
15 electrical circuit, and the metallic mass of the vehicle causes a variation in the magnetic field produced by the first circuit, which in turn causes a variation in the flux linking a second circuit formed by the metallic masses in the wheel and, more particularly, by the torus formed by the wheel rim
20 and the metallic tyre reinforcements, thus inducing a current in the second circuit.

We believe that such reasoning is erroneous since it would cause a change in the inductance of the loop opposite to the results actually described and shown in EP-A-0,649,553.
25 In fact, whilst the large conducting area of a vehicle body causes a decrease in the loop inductance due to eddy currents, the vehicle tyre contains ferrous metal but in the form of steel bands or webbing, not in the form of a large conducting sheet. The vehicle tyre thus has a high magnetic
30 permeability, but a relatively low electrical conductivity, and causes an increase in the loop inductance.

Summary of the Invention

It is an aim of the present invention to provide a vehicle detector which is able to detect vehicle wheels, tyres

and hence axes more accurately than has been possible hitherto.

Accordingly, the present invention comprises a vehicle detector and classifier comprising at least one electrically conductive loop arranged in a road surface, characterised in that the or each loop is arranged substantially in a plane perpendicular to the road surface.

Said plane may extend parallel to the axis of the road, i.e. in the direction of travel, but preferably it extends across the road. This means that a plurality of loops may be arranged in a line in a single transverse slot cut into the road surface.

The or each loop may comprise a plurality of turns. The signal processing circuitry used to sample the inductance of the loop and operate on the samples may comprise one of a number of conventional arrangements currently used in inductive loop vehicle detectors. In this regard, some of the active electronic components, such as the oscillator, can be located in the slot adjacent to the or each loop so as to reduce interference between the loops and reduce crosstalk between the circuits. Any such components are preferably mounted on very small hybrid or thick-film circuits at regular intervals. The loop, or all of the loops, and optionally the locally mounted components, are preferably encapsulated in a semi-rigid enclosure which is strong yet flexible so as to be able to withstand the forces exerted by heavy vehicles passing thereover.

The or each loop may be of any suitable shape, for example substantially rectangular, and may, for example, have a length of between 5 and 15 cm and a width (i.e. a depth) of between 1 and 3 cm. In a particular embodiment, a plurality of loops each measure approximately 10 cm x 2 cm.

In a preferred embodiment of the invention, the detector also includes an inductive loop arranged substantially in the plane of the road surface. This conventional loop is used to detect vehicle bodies whilst the or each vertically-orientated loop is used to detect wheels. Preferably, the detector includes means for superposing results obtained from the conventional and vertically-orientated loops and means for displaying the superposed results. Thus, a profile showing both the chassis and the axles or wheels of a vehicle can be viewed.

Brief Description of the Drawings

The present invention will now be described in more detail, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a schematic vertical elevation of a vehicle detector according to one embodiment of the invention;

Figure 2 is a schematic transverse section of the detector shown in Figure 1;

Figures 3a and 3b schematically show an alternative embodiment of detector at two different instants for double and single tyres respectively;

Figures 4a and 4b are plots of results obtained from the detector as shown in Figures 3a and 3b respectively;

Figure 5 is a schematic bottom view of a model vehicle;

Figures 6a and 6b are surface and contour plots respectively obtained when the vehicle shown in Figure 5 passes over a detector according to the invention; and

Figure 7 is a plot of superposed results obtained from a combined detector according to another alternative embodiment.

Detailed Description of the Preferred Embodiments

Figures 1 and 2 show a detector comprising a linear array of inductive loops 1, the number of loops being as required to cover the width of carriageway to be monitored. For example about 20 loops can cover a width of 3 m. In this example, each loop measures 10 cm x 2 cm. The array of loops is arranged in a narrow slot 2 extending transversely across a road surface. Each loop 1 comprises a plurality (e.g. 20 to 30) turns of wire. Each loop 1 is both energised and monitored by an adjacent electronic circuit 3, comprising, *inter alia*, an oscillator and circuitry to convert the oscillation frequency into a proportional signal voltage (not shown in detail). The circuits 3 are very small hybrid or thick-film circuits. The entire array of loops 1 and circuits 3 is housed within a semi-rigid enclosure 4 for protection against the mechanical forces exerted by vehicles passing over the detector.

The signal processing circuitry used to operate inductive loop vehicle detectors is well documented and no special adaptations are required for operating the detector of the present invention. It is not therefore necessary to set out the details of the circuitry herein. An example of such circuitry is described in EP-A-0,649,553, but other known arrangements are equally suitable for use with the present invention.

Figures 3a and 3b schematically show an embodiment of the invention comprising two 10 cm x 2 cm loops 5a, 5b which was built and tested. The two-loop array was mounted in a narrow trench and a large van was driven thereover. Figure 3a shows a front wheel 6 of the van passing over the loop 5a whilst Figure 3b shows doubled rear wheels 7 passing over both loops 5a, 5b. The results are plotted in Figures 4a and 4b, with the solid line showing the ADC (analogue-to-digital converter) reading for the loop 5a and the broken line showing the ADC reading for the loop 5b. Figure 4a shows the recording corresponding to Figure 3a and Figure 4b the recording of

Figure 3b. The outputs are very distinct, giving a clear indication of the presence of the wheel and it is possible to see the difference between the front and rear wheels. The presence of the large conducting area of the underside of the van has not destroyed the data relating to the wheels, as would happen with a conventional loop.

Figure 5 shows the dimensions in mm of a scale model vehicle used to test an experimental embodiment of the invention. The model vehicle had wheels exhibiting the same properties as real vehicle wheels. Figures 6a and 6b show the results obtained as a 3D surface plot and a contour plot respectively.

A practical embodiment of the invention comprises at least one vertically-orientated inductive loop as described above as well as a conventional large flat loop which may be up to 1.5 to 2.5 m long in the direction of travel. Such a combined detector has been constructed. The results from the vertical and flat loops were superposed, the results from the vertical loop firstly being inverted since, as explained above, tyres cause a increase in the loop inductance whilst the vehicle body causes a decrease. The superposed results are shown in Figure 7 as an illustration of what can be achieved. The profile indicates both the chassis and the axles of the vehicle. This could also be displayed as a 3D plot, similar to Figure 6a, if an array of vertically oriented loops is used such as that shown in Figure 1.

When the detector comprises a linear array of miniature loops it is possible to detect the track width and even the size and configuration of the vehicle wheels. The lateral position of the vehicle on the road can be detected and thus a vehicle straddling two lanes of a road is easily identified and is not mistaken for two vehicles. Metal-tracked vehicles can also be distinguished since the tracks will cause a decrease in the loop inductance, whereas tyred vehicles cause an increase in inductance.

The inductive signature of the loop(s) of the invention has a better resolution than that of conventional loops due to the size and orientation of the loop of the invention. This helps to resolve tailgating and nose-to-tail congestion problems encountered by conventional loops. This range of data is not readily available from video processing, even in good weather and lighting conditions.

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CLAIMS

1. A vehicle detector and classifier comprising at least one electrically conductive loop arranged in a road surface, characterised in that the or each loop is arranged
5 substantially in a plane perpendicular to the road surface.
2. A detector according to claim 1, characterised in that said plane extends across the road.
3. A detector according to claim 1, characterised in that said plane extends parallel to the axis of the road, i.e. in
10 the direction of travel.
4. A detector according to any preceding claim, characterised in that a plurality of loops are arranged in a line in a single slot cut into the road surface.
5. A detector according to claim 4, characterised in that
15 at least one active electronic component is located in the slot adjacent to each loop.
6. A detector according to claim 5, characterised in that the components are mounted on very small hybrid or thick-film circuits at regular intervals.
- 20 7. A detector according to any preceding claim, wherein the loop, or all of the loops, are encapsulated in a semi-rigid enclosure.
8. A detector according to any preceding claim, wherein the or each loop is substantially rectangular.
- 25 9. A detector according to any preceding claim, wherein the or each loop comprises a plurality of turns.

10. A detector according to any preceding claim, including an inductive loop arranged substantially in the plane of the road surface.

11. A detector according to claim 10, including means for
5 superposing a result obtained from the loop arranged substantially in the plane of the road surface and a result obtained from the or each loop arranged substantially in a plane perpendicular to the road surface, and means for displaying the superposed results.

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ABSTRACT

A vehicle detector and classifier comprises a plurality of electrically conductive loops 1 arranged substantially in a plane perpendicular to a road surface, for detecting vehicle wheels. The loops can be arranged in a transverse, vertical slot 2 and housed in a flexible enclosure. An electronic circuit 3, including an oscillator, can be positioned adjacent each loop 1 in the slot 2 to energise and monitor the loop. The detector preferably also includes a conventional loop 10 arranged substantially in the plane of the road surface, for detecting vehicle bodies, and means for superposing the results obtained from the conventional and vertical loops to aid in classifying detected vehicles.

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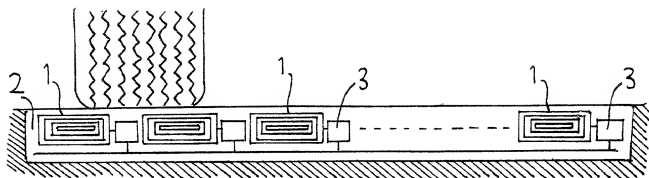


Fig. 1

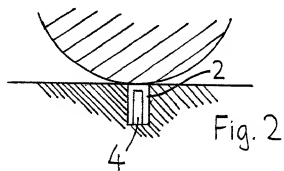


Fig. 2

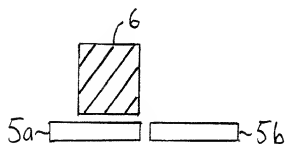


Fig. 3a

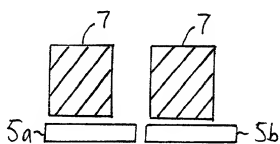


Fig. 3b

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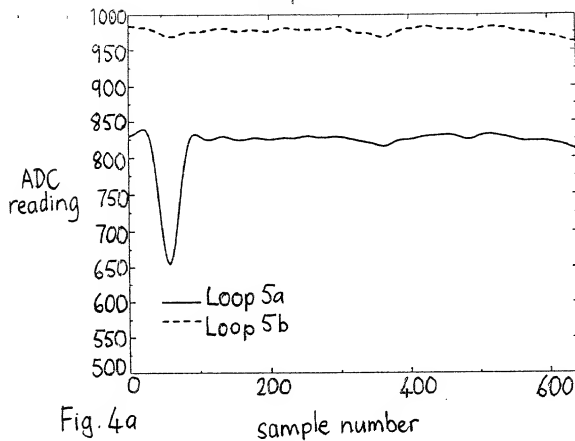


Fig. 4a

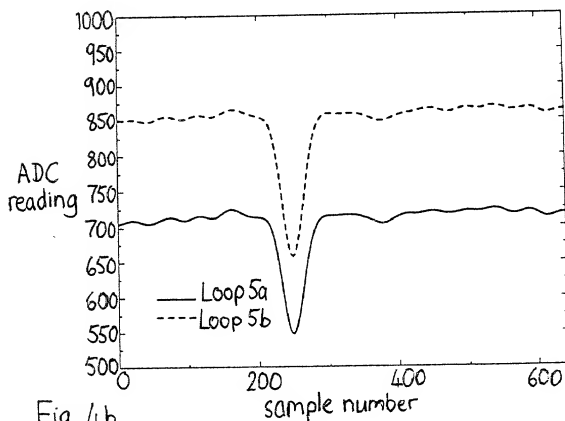


Fig. 4b

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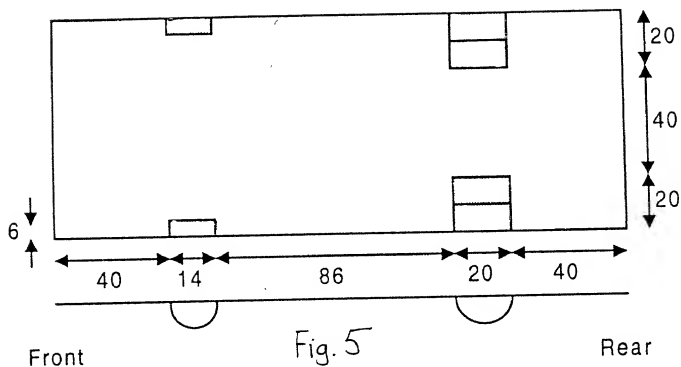


Fig. 5

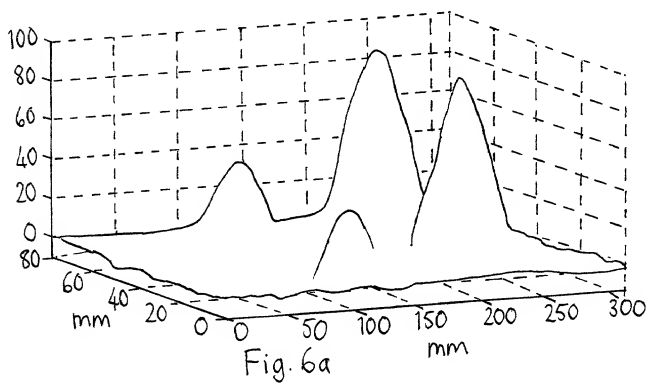


Fig. 6a

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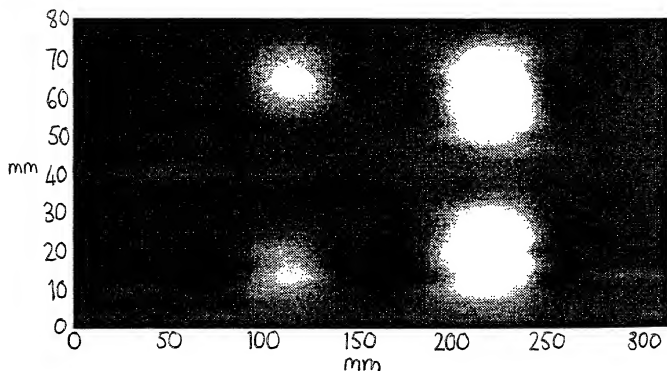


Fig. 6b

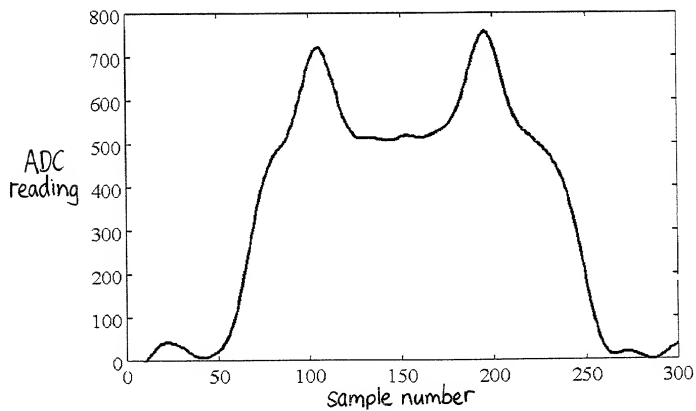


Fig. 7

COMBINED DECLARATION AND POWER OF ATTORNEY

(PATENT - ORIGINAL, DESIGN, NATIONAL STAGE OF PCT)

As a below named inventor, I hereby declare that:

TYPE OF DECLARATION

This declaration is of the following type: (check one applicable item below)

<input type="checkbox"/>
<input type="checkbox"/>
<input checked="" type="checkbox"/>

Original

Design

National stage of PCT

INVENTORSHIP DECLARATION

My residence, post office address and citizenship are as stated below next to my name, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: VEHICLE DETECTOR AND CLASSIFIER

SPECIFICATION IDENTIFICATION

the specification of which:

☐

is attached hereto.

☐

was filed on _____ as Serial No. _____
and was amended on _____ (if applicable).

NOTE Amendments filed after the original papers are deposited with the PTO which contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.

☒

was described and claimed in PCT International Application No. PCT/GB00/00568 filed on 17.2.00 and as amended under PCT Article 19 on _____ (if any).

ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all known information which is material to patentability as defined in Title 37, Code of Federal Regulations. § 1.56.

☐

In compliance with this duty there is attached an information disclosure statement. 37 CFR 1.97.

PRIORITY CLAIM

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the

United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

☐

no such applications have been filed.

☒

such applications have been filed as follows.

NOTE Where item (c) is entered above and the International Application which designated the U.S. claimed priority check item (a), enter the details below and make the priority claim.

EARLIEST FOREIGN APPLICATION(S), IF ANY FILED WITHIN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION

Country	Application Number	Date of Filing	Priority Claimed under 37 U.S.C. 119
GB	9903783.0	18.2.99	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No
			<input type="checkbox"/> Yes <input type="checkbox"/> No

ALL FOREIGN APPLICATION(S), IF ANY FILED MORE THAN 12 MONTHS
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION

POWER OF ATTORNEY

As a named inventor, I hereby appoint the following registered practitioners to prosecute this application and transact all business in the Patent and Trademark Office connected therewith:

13 Lewis F. Gould, Jr., Registration No. 25,657; William H. Murray, Registration No. 27,218; Stephan P. Gribok, Registration No. 29,643; Peter J. Cronk, Registration No. 32,021; Robert E. Rosenthal, Registration No. 33,450; Richard A. Paikoff, Registration No. 34,822; Samuel W. Apicelli, Registration No. 36,427; Steven E. Koffs, Registration No. 37,163; N. Stephen Kinsella, Registration No. 37,657; Daniel S. Goldberg, Registration No. 39,689; Gail A. Dalickas, Registration No. 40,979; Darius C. Gambino, Registration No. 41,472 and Anthony Colesanti, Registration No. 42,428.

Please direct all correspondence to:

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DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or

both, under Section 1001 of Title 18 of the application or any patent issued thereon.

SIGNATURE(S)

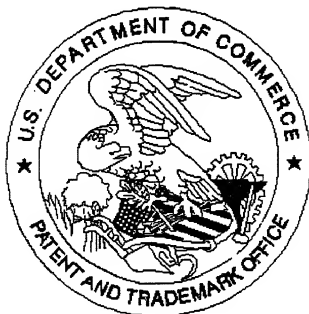
100
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Inventor's signature Gordon Povey
Date 30th July 2001 Country of Citizenship United Kingdom
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200
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Inventor's signature Thomas S.M. Maclean
Date 31st July 2001 Country of Citizenship United Kingdom
Residence Perth, United Kingdom GBX
Post Office Address 16 Fairies Road, Perth PH1 1NB, United Kingdom

Full name of third joint inventor, if any _____
Inventor's signature _____
Date _____ Country of Citizenship _____
Residence _____
Post Office Address _____

Attorney Docket No: 668-62

United States Patent & Trademark Office
Office of Initial Patent Examination -- Scanning Division



Application deficiencies found during scanning:

☐ Page(s) _____ of _____ were not present
for scanning. (Document title)

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Drawing figure 4 is too dark.

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